

Regulating Availability with Demand Uncertainty

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Abstract

I evaluate German regulation that requires retail discounters to guarantee the availability of their products in bargain sales. The regulation is meant to prevent loss leaders. Retailers however claim that rationing is due to demand uncertainty and thereby undermine the regulation's rationale. Indeed, demand uncertainty explains empirical observations better than a theory of loss leaders. This paper shows, however, that also under demand uncertainty the regulation has positive effects. Ultimately, it raises production, which, under imperfect competition, is beneficial. A strict regulation overshoots its goal when high demand is relatively unlikely. In this case more sophisticated regulation is required.

Keywords: bargain sales, demand uncertainty, regulation.

JEL Classification No.: L51, L23, D21

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1 Introduction

This paper studies new German regulation that outlaws an observed rationing of bargain sales. The regulation is seen as an indirect, more effective way to enforce the law against loss leaders. Retail discounters claim, however, that rationing is mainly due to demand uncertainty and, therefore, does not indicate a practise of loss leaders. This claim raises the question how the regulation impacts market outcomes when rationing is due to demand uncertainty rather than loss leaders. I show that, also from the perspective of demand uncertainty, the regulation has positive effects.

Bargain sales by discounters are a relatively new phenomenon in Germany's retailing industry. According to the German Retail Association, HDE, they helped discounters to increase sales in 2002, contradicting the 3.5 percent decline in the overall retail sector.¹ This trend continued in 2003. Recently, the main German players, Aldi and Lidl, have successfully introduced the business model in other countries.² As a result, the importance of these non-food bargain sales have risen dramatically. For instance, Aldi, Germany's main discounter, now attributes 20 percent of its sales to these special bargains.³ As a consequence, bargain sales are seen as an important innovation to Germany's distribution system. In December 2002, however, the German ministry of consumer protection expresses concerns that discounters may abuse the bargain sales as "loss leaders" to lure consumers.⁴ As an indication of such abuse, the ministry notes that bargains have limited availability and often lead to a rationing of consumers. The practise of loss leaders is forbidden in Germany, but explicit enforceability is difficult. Hence, the ministry argued that an efficient, indirect way to limit potential abuse is to force discounters to guarantee the availability of their bargains. In July 2004, the ministry's proposal entered into German law.⁵ The new law

¹HDE, 30th Januar 2003: <http://www.einzelhandel.de/servlet/PB/menu/1015217/index.html>.

²E.g. Aldi uses the business model in 15 different countries, including Australia and the US. Lidl operates the model throughout the European Union.

³Source: Lebensmittelzeitung 49, December, 5th, 2003.

⁴Der Spiegel 50/2002, p.19. See also <http://www.spiegel.de/spiegel/vorab/0,1518,226152,00.html>.

⁵§5(5) Gesetz gegen den unlauteren Wettbewerb; BGBl. Teil I/2004, Nr. 32 (7.7.2004), S. 1414 ff.

against unfair competition now outlaws an advertising for goods which are held without appropriate quantities. The respective paragraph, §5(5), explicitly defines "appropriate" as "a coverage of demand for two days" under normal circumstances.

Discounters contest the ministry's accusation that they practise loss leaders. For instance, in its customers service announcement to consumers Aldi-Süd explicitly writes that they "plan the availability of bargains very carefully."⁶ But point out that despite careful planning "customers' demand cannot be exactly predicted," because it is "partially affected by factors that are difficult for us to foresee." For this reason it may therefore happen that "when ordering the quantity of bargains we may under- or overestimate consumer demand."

Hence, discounters claim that rationing occurs due to demand uncertainty and not because of a practice of loss leaders. They substantiate their claim by pointing out that in many cases bargain sales lead to an oversupply, which is inconsistent with the practise of loss leaders.⁷ In fact, there is evidence that the problem of oversupply has taken such proportions that it now poses a severe threat to the business model of bargain sales.⁸ The bankruptcy of the firm 4MBO is only one illustration of these problems. This firm produced the initially very successful bargain PC, "VolksPC", of the discounter Plus. However, in December 2003 it shocked capital markets with its announcement that, due to a "dramatic decline in PC sales" and "sustained low level of

⁶Original German text on http://germany.aldi.com/corporate_09/index.html: "Wir bemühen uns intensiv darum, ausreichende Mengen von Aktionsartikeln bereit zu halten. Wir planen die Mengen der Angebote sehr sorgfältig unter Berücksichtigung aller uns zur Verfügung stehenden Informationen. Dazu zählen insbesondere die Erfahrungen aus vorangegangenen Aktionen. Trotzdem kann die Kundennachfrage nie exakt eingeschätzt werden. Ihre Kaufentscheidung wird zum Teil von Faktoren beeinflusst, die für uns nur schwer vorherzusehen sind. Es kann daher im Ausnahmefall vorkommen, dass wir bei der Bestellung eines Aktionsartikels die Verbrauchernachfrage unter- beziehungsweise überschätzen."

⁷Another observation that contradicts the loss leader theory is that exactly those bargain sales that are sold out and lead to rationing are actually the highly profitable ones.

⁸E.g. <http://www.rp-online.de/public/article/wirtschaft/deutschland/29926>. *Lebensmittelzeitung* 49, December, 5th, 2003 reports that, as a rule of thumb, the success of a discount sale depends on how well the last 20 percent of the units sell.

consumer spending”, it had to close down its PC manufacturing unit. The subsequent restructuring led to such losses that the firm became insolvent and, two months later, had to file for bankruptcy.⁹ In a press statement 4MBO explains that bargain sales require a high volume to be profitable, but actual demand did not meet these.¹⁰

In the light of these claims and the supporting observations, the regulation should be (re)evaluated from a perspective of demand uncertainty. In particular, the discounters’ claims raise the question whether the regulation may actually worsen market outcomes when the main rationale behind rationing is indeed demand uncertainty and not loss leaders. This paper therefore studies the effects of the regulation when the underlying reason behind rationing is, in fact, demand uncertainty. I show however that also in this case the regulation has positive effects. As it increases production, it is potentially welfare enhancing in any market setting with incomplete competition.

Although German bargain sales are practised by different discounters, they all follow more or less the pattern of Aldi, the initiator of the German bargain sales. Every week Aldi announces a set of products that it will offer in the coming week. The announcements are nation wide and explicitly stipulate prices. The products themselves do not belong to the store’s usual selling stock and their supply is limited. Although the type of product varies extremely and ranges from PCs and DVD/MP3 players to clothing and indoor plants, bargain sales have been especially successful for electronic products. A prime example was a bargain sale of personal computers in the last quarter of 2002. Ordering these PCs from the supplier Medion, the discounter managed to sell 300,000 units in its weekly sale. Medion thereby became Germany’s market leader in PCs.¹¹ The fact that these discounters normally sell groceries and have little expertise in, for example, computers gives further credence to their claim that they act under demand uncertainty.

⁹Sources: DGAP-Ad hoc statements of 17.12.03, 27.02.04, and 01.03.04; accessible at <http://www.dgap.de/>.

¹⁰Source: <http://www.golem.de/0312/28978.html>.

¹¹Source Gartner-Dataquest. See also: [http://www.golem.de/showhigh.php?file=/0301/23748.html&wort\[\]=medion](http://www.golem.de/showhigh.php?file=/0301/23748.html&wort[]=medion)

It is also natural that demand uncertainty plays a much larger role to these discounters than to a specialized retailer, who may collect information about unexpected changes in demand from his day to day sales. This information is unavailable to a discounter who sells the product at most once every six months.

Since the primary focus of this paper is on the effect of regulation and the interaction between a discounter and its consumers, I will disregard any strategic effects vis-a-vis other potential producers and treat the discounter as a monopolist.¹² The monopoly setting clearly illustrates the effects of the regulation under demand uncertainty, but is not crucial for the results. Ultimately, the regulation induces the firm to increase output. Since firms in a setting with imperfect competition tend to choose a suboptimally low quantity, the regulation is beneficial if the increase is not too extreme. Available evidence strongly suggests that, despite increased entry, the market is still characterized by imperfect competition.¹³

A theoretical analysis of monopolistic behavior under demand uncertainty may be found in Mills (1959), Karlin and Carr (1962), Zabel (1970) and Young (1978). Applications of these models include a study of stochastic inventory control (Whitin (1955), Petruzzi and Dada (1999)), capacity choices (Smith (1969)), resale price maintenance (Deneckere et. al (1996)), and price dispersion (Dana (1999)). The question of regulating availability in a model with demand uncertainty has, however, not been studied. Economic literature has also studied models of sales and advertisement (e.g. Butters (1977), Varian (1980), Bester (1994)). However, these models are not directly related to the current paper, because they are based on search costs and/or imperfectly informed consumers.

¹²The monopoly assumption is appropriate in settings in which the firm has a short run production opportunity to benefit from a drastic cost reduction due to extreme economies to scale. The importance of economies to scale is supported by the statement of 4MBO that “large sales campaign volumes are essential for generating profits with discount computers” (DGAP-ad-hoc statement on 17.12.2003; accessible at <http://www.dgap.de>).

¹³Lebensmittelzeitung 49 reports that bargain sales products have profit margins of 35 to 40 percent.

The rest of the paper is organized as follows. The next section introduces a simple monopoly model with demand uncertainty. As a first step, Section 3 analyzes the firm's behavior if it concentrates on the low state of demand only. In Section 4, I study the outcome under regulation, where the firm is forced to guarantee availability. Section 5 studies the optimal rationing behavior of a firm which is free of regulation. Section 6 compares the effect of regulation by contrasting the results of Section 4 and Section 5. Section 7 concludes. All formal proofs are relegated to the appendix.

2 The Setup

Consider a firm producing a good under demand uncertainty; the firm has to commit to a uniform price, p , and a quantity, q , without knowing the exact demand.¹⁴ To make this more precise, let α denote the probability that the consumers' willingness to pay, v , is uniformly distributed over $[0, 1]$ and let $1 - \alpha$ represent the probability that the consumers' willingness is uniformly distributed over the interval $[-1/4, 3/4]$.^{15,16} Hence, demand is high with probability α , while with probability $1 - \alpha$ demand will be low. The firm operates a production function with a constant marginal costs of $c \in (0, 1/2)$. Fixed costs are zero.

The exact timing is as follows:

t=1: The firm chooses a price quantity combination (p, q) .

t=2: The state of demand realizes.

¹⁴Dana (1999) notes that under demand uncertainty firms may have an incentive to use non-linear prices. Yet, German discounters typically commit to a single uniform price that is independent of the quantity sold. It is, therefore, more appropriate to limit the firm's pricing strategy to uniform prices.

¹⁵These specific assumptions lead to simple demand structures that allow a straightforward and tractable analysis. The specific distributions are chosen to prevent corner solutions and ensure that internal solutions lead to positive demand.

¹⁶With free disposal a consumer can always guarantee himself the outside option. An explicit consideration of this would yield a mass point of $1/4$ at $v = 0$, but this does not affect results in any way.

t=3: Consumers decide whether to buy the product.

In order to buy the product, potential consumers need to travel to the firm's outlet and incur positive transportation costs of t , where $t < 3/4 - c$.¹⁷ The consumers' outside option not to buy the product is normalized to zero.

Because demand is uncertain, the firm faces a dilemma. If it chooses a price quantity combination (p, q) that satisfies consumers' demand in the high state, it will be unable to sell all its produced units if demand turns out to be low. That is, some of the produce will go to waste and, given the positive marginal cost of production c , the firm had been better off producing less.¹⁸ On the other hand, if the firm chooses a combination (p, q) to ensure that the entire produce is sold in the low state, there will be an excess of demand if demand turns out to be high. In this case, the firm would have been better off by choosing a larger quantity. Effectively, the firm faces a trade-off between producing too few products in the high state and too many in the low state.

If the firm chooses a price quantity combination that leads to an excess of demand in the high state, there is rationing. In this case, there must be some rule by which consumers are rationed. For bargain sales the appropriate rule seems to be proportional rationing, where all consumers who arrive at the shop receive the product with equal probability. As is well known, this rule leads to an inefficient allocation of products and there exists gains of trade between consumers. However, for bargain sales such renegotiation does not seem to take place in practise.

3 Focus on Low Demand

It is instructive to start the analysis by considering a firm that focuses exclusively on the low state of demand and disregards the possibility to increase

¹⁷For $c + t > 3/4$ there exist no gains of trade in the low state of demand and the existence of this state is immaterial.

¹⁸The assumption that unsold products are simply waste is an extreme, but straightforward illustration of a depreciation of the product's value. The crucial assumption is that the firm is unable to recoup his costs c for an unsold unit.

production to sell more units in the high state.¹⁹ In this case, the firm chooses a price quantity combination (p, q) which covers exactly the demand in the low state; more production leads to waste in the low state, while less production leads to a loss of potential demand. Hence, an exclusive focus on the low state of demand renders the trade-off between producing too few or too many products trivial. It leads to exactly the right number of units for the low state and too little production in the high state.

As a consequence, consumers who visit the shop in the low state of demand are sure to receive the product. Hence, given a price combination (p, q) that satisfies potential demand, a consumer v will buy the product if

$$v - p - t \geq 0.$$

Consequently, all consumer with a willingness to pay that exceeds $\bar{v} \equiv p + t$ buy the product. Since the willingness to pay in the low state is uniformly distributed over $[-1/4, 3/4]$, it follows that demand is

$$D_l(p) = 3/4 - p - t.$$

Hence, given that the firm chooses a price quantity combination which matches exactly the demand in the low state, he restricts attention to combinations $(p, D_l(p))$. Since for any such combination he sells $D_l(p)$ units both in the low and the high state, the firm's profit is

$$\Pi_1(p) \equiv (p - c)D_l(p).$$

Consequently, the monopoly price, which maximizes the firm's profit, is

$$p_1^* \equiv (3 + 4c - 4t)/8.$$

Proposition 1 *The optimal price quantity combination that satisfies the demand in the low state is $(p, q) = (p_1^*, q_1^*) \equiv ((3 + 4c - 4t)/8, (3 - 4c - 4t)/8)$.*

Since only $D_l(p_1^*)$ units are available, the outcome of Proposition 1 implies that consumers are rationed if demand turns out to be high. In this case, the firm would have been better off, if he had produced more units.

¹⁹Whether this selling strategy is actually optimal I address in Section 5.

4 Regulating Availability

This section analyzes the firm's pricing behavior, when it is forced to guarantee the availability of the product to all potential consumers. Basically, it reflects the counter part of Section 3, because the firm's choice must now ensure that demand in the high state is fully covered. Obviously, the firm will not choose a higher quantity and, due to the assumed regulation, the firm is unable to produce less. In contrast to the previous section, the firm will therefore produce too many units if demand turns out to be low.

Under regulation rationing does not occur. Hence, in both states of demand a consumer with a willingness to pay that exceeds \bar{v} will buy the product. Consequently, the demand of consumers in the high state is

$$D_h(p) \equiv 1 - \bar{v} = 1 - p - t.$$

Given that the firm is forced to guarantee availability, it therefore chooses some price quantity combination $(p, D_h(p))$. As the firm sells only $D_l(p)$ units when demand turns out to be low, the firm's expected profit is

$$\Pi_2(p) \equiv \alpha p D_h(p) + (1 - \alpha) p D_l(p) - c D_h(p). \quad (1)$$

Proposition 2 *Under forced availability, the optimal price quantity combination is $(p, q) = (p_2^*, q_2^*) \equiv ((3 + \alpha + 4c - 4t)/8, (5 - \alpha - 4c - 4t)/8)$.*

A direct comparison of the optimal combination (p_2^*, q_2^*) with (p_1^*, q_1^*) reveals that under regulation the price is higher. This follows directly from the simple fact that consumers' willingness to pay is lower in the low state of demand.

5 No Regulation

This section studies the firm's optimal behavior when there is no regulation. In this case, the firm will not choose a price quantity combination that leads to an excess of demand in the low state; the firm would be better off offering

the same quantity at a higher price. Consequently, consumers are sure to receive a product in the low state and it follows that demand in the low state is $D_l(p) = 3/4 - p - t$. On the other hand, the firm will not choose a price quantity combination, that results in an excess supply in the high state; it leads to a number of unsold units in both the high and the low state.

It follows that the firm chooses a combination (p, q) such that it either satisfies demand in both states, or rationing occurs for the high state only. If rationing occurs, consumers are not sure to receive a product when they arrive at the shop. When deciding about visiting the shop, a rational consumer will consider this possibility explicitly. Given that a consumer believes to receive a product with probability π^e , his expected payoff from buying the product is $\pi^e(v - p) - t$. Hence, a consumer with a willingness to pay that exceeds $\bar{v}_h \equiv p + t/\pi^e$ decides to visit the shop. Since the willingness to pay in the high state is uniformly distributed over $[0, 1]$, demand is

$$D_h = 1 - p - t/\pi^e. \quad (2)$$

Given the proportional rationing rule, the probability of receiving a product is q/D_h . In a rational expectation equilibrium, the consumers' beliefs are confirmed so that $\pi^e = q/D_h$. Substitution in (2) and a rearrangements of terms yields

$$D_h(p, q) \equiv \frac{1 - p}{1 + t/q}.$$

Note that the demand in the high state depends positively on the produced quantity q . This obtains, because a larger quantity increases the likelihood that a consumer actually receives the product if he visits the shop.

The firm chooses a price quantity combination (p, q) that maximizes expected profit. Since in the low state the firm sells only $D_l(p)$ units, profits are $\Pi_l(p, q) = D_l(p)p - cq$. In the high state, it sells all units so that its profit is $\Pi_h(p, q) = (p - c)q$. Expected profits are therefore

$$\Pi_3(p, q) = \alpha[(p - c)q] + (1 - \alpha)[(3/4 - p - t)p - cq].$$

As discussed, the firm chooses a combination such that there is no excess demand in the low state ($q \geq D_l(p)$) and no excess supply in the high state

($q \leq D_h(p)$). For a given price p this implies that the firm restricts its quantity to the interval $q \in [3/4 - p - t, 1 - p - t]$. Hence, given some price p the optimal quantity solves

$$\max_{q \in [3/4 - p - t, 1 - p - t]} \Pi_3(p, q).$$

Since $\Pi(p, q)$ is linear in q , the optimal q is either $3/4 - p - t$ or $1 - p - t$. This insight reveals that the firm, effectively, chooses between two selling strategies. Either it concentrates on low demand and, as a direct consequence, rations consumers in the high state. Or, it focuses on the high state of demand and chooses a quantity which will satisfy the entire demand in the high state. The optimal price quantity combination coincides therefore either with the solution (p_1^*, q_1^*) of Section 3 or the solution (p_2^*, q_2^*) of Section 4.

It is intuitive that the firm's optimal choice depends on the likelihood that the state of demand is high; the higher the probability that demand is high, the more profitable a focus on the high demand state. To make this more precise, define

$$\bar{\alpha} \equiv \sqrt{(3 + 4c - 4t)^2 + 16c} - (3 + 4c - 4t).$$

We arrive at the following result:

Proposition 3 *For $\alpha \leq \bar{\alpha}$ the optimal price quantity combination is $(p, q) = (p_1^*, q_1^*)$ and leads to a rationing of consumers in the high state. For $\alpha > \bar{\alpha}$ the price quantity combination $(p, q) = (p_2^*, q_2^*)$ is optimal.*

The proposition confirms the intuition that the firm concentrates on the low state of demand if and only if the likelihood of a high state of demand is low enough ($\alpha < \bar{\alpha}$).

6 The Effect of Regulation

In order to evaluate the different outcomes we address the welfare effects of regulation. For $\alpha > \bar{\alpha}$ regulation has no effect, since the firm already chooses a quantity that guarantees that demand is satisfied. Regulation in this case is superfluous.

For $\alpha \leq \bar{\alpha}$ the firm would like to ration consumers in the high state of demand, but regulation forces it to serve all consumers. A priori it is, however, unclear which of the two settings consumers prefer. The outcome with rationing leads to lower prices, but at the risk of not receiving a product in the high state. To arrive at a definite answer, I calculate the consumers' surplus explicitly. First, without regulation rationing occurs in the high state of demand so that a consumer receives a product with probability $\pi = q_1^*/D_h(p_1^*, q_1^*)$. The expected ex ante consumers' surplus is therefore

$$\begin{aligned} CS^1 &\equiv \alpha \int_{\bar{v}_h}^1 [(v - p_1^*)\pi - t]dv + (1 - \alpha) \int_{\bar{v}_l}^{3/4} [v - p_1^* - t]dv \\ &= \frac{(3 + 2\alpha - 4c + 4t)(3 - 4c - 4t)^2}{128(3 - 4c + 4t)}. \end{aligned} \quad (3)$$

Under regulation there is no rationing so that the expected ex ante consumers' surplus is

$$\begin{aligned} CS^2 &\equiv \alpha \int_{\bar{v}_h}^1 (v - p_2^* - t)dv + (1 - \alpha) \int_{\bar{v}_l}^{3/4} (v - p_2^* - t)dv \\ &= ((3 - 4c - 4t)^2 + 2\alpha(5 - 4c - 4t) - 3\alpha^2)/128. \end{aligned} \quad (4)$$

A direct comparison between CS^1 and CS^2 yields the following result:

Proposition 4 *For any $\alpha \in (0, 1]$ the ex ante expected consumers' surplus is strictly larger without rationing.*

The proposition shows that, despite higher price, consumers always prefer the outcome without rationing. Hence, when $\alpha < \bar{\alpha}$, the preferences of consumers and the firm contradict.²⁰ When the firm's decision about rationing is at the margin $\bar{\alpha}$, the firm is indifferent, while consumers have a

²⁰This observation has the interesting implication that consumer pressure groups will lobby in favor of regulation.

strict preference not to ration. Consequently, the firm's decision to ration for somewhat smaller α is a suboptimal decision from a welfare perspective. To investigate this more precisely we calculate the effect of regulation on ex ante expected social welfare, which is the sum of expected ex ante profits and the ex ante expected consumer surplus.

For $\alpha \leq \bar{\alpha}$ the welfare effect of regulation is therefore

$$\begin{aligned}\Delta W &\equiv [\Pi_2(p_2^*) + CS^2] - [\Pi_1(p_1^*) + CS^1] \\ &= \frac{\alpha}{128} (16 + 16c - \alpha) - \frac{\alpha t^2}{3 - 4c + 4t} - \frac{c}{4}.\end{aligned}\tag{5}$$

Again, the optimal behavior will depend on the likelihood of the high state of demand. Consequently, define

$$\tilde{\alpha} \equiv \frac{8(\phi(c, t) - \sqrt{\phi(c, t)^2 - c(3 - 4c + 4t)^2/2})}{3 - 4c + 4t},$$

where

$$\phi(c, t) \equiv (3 - c - 4c^2 + 4(1 + c)t - 8t^2).$$

Proposition 5 *For $\alpha \in (\tilde{\alpha}, \bar{\alpha}]$ regulation increases ex ante expected social welfare. For $\alpha < \tilde{\alpha}$ regulation reduces ex ante expected social welfare. For $\alpha > \bar{\alpha}$ regulation is superfluous.*

The proposition shows that regulation is only beneficial if the likelihood of a high state of demand is not too small. Indeed, for α close to zero ensuring availability for the high demand state is not beneficial, since it occurs with very small probability. In this case, regulation almost always causes excess supply, which only increases costs. This illustrates that also from a social welfare perspective there is a trade-off between producing too much in the low state and producing too little in the high state. The only difference is that the weights in the trade-off differ; social welfare takes into account the effect on consumers' surplus, whereas the firm neglects it. Since the consumers' surplus is greater without rationing, the difference implies that the interval of values for α for which the firm rations customers is too large from a social welfare perspective.

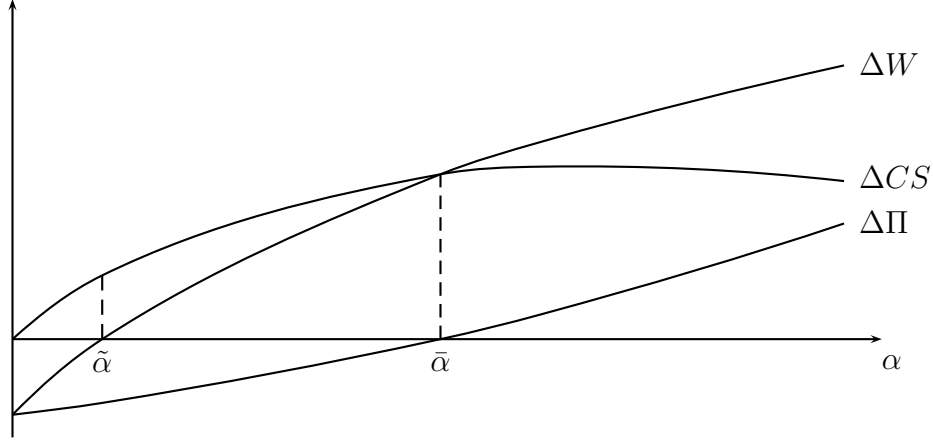


Figure 1: Difference in surpluses as a function of α .

Figure 1 summarizes the findings graphically. Since consumers always prefer the regulated outcome, the curve $\Delta CS \equiv CS^2 - CS^1$ lies in the positive quadrant. For $\alpha = 0$ the consumers are indifferent about regulation ($\Delta CS = 0$), because the firm sets identical prices and rationing occurs with probability zero. The increasing curve $\Delta \Pi \equiv \Pi_2 - \Pi_1$ reflects the fact that the rationing strategy becomes less attractive as the probability of the high state increases. Consequently, the rationing strategy yields higher profits for small α , whereas the firm prefers not to ration when α exceeds $\bar{\alpha}$. Since welfare is the sum of consumers' surplus and the firm's profit, the curve ΔW is simply the addition of ΔCS and $\Delta \Pi$. Since both functions are quadratic in α , also their addition ΔW is quadratic in α . Moreover, at $\bar{\alpha}$ the firm is indifferent about rationing and the curve ΔW coincides with ΔCS and is, therefore, positive. On the other hand, at $\tilde{\alpha}$ it holds $\Delta W = 0$ implying that ΔCS and $\Delta \Pi$ just cancel each other out. The parabolic shape of ΔW then implies that for the range $(\tilde{\alpha}, \bar{\alpha})$, expected social welfare is strictly higher without rationing, while profits are lower.

7 Conclusion

This paper shows that in a market with demand uncertainty a producer faces a trade-off between rationing and overproduction. Rationally, the producer

opts for rationing, when he perceives the probability of a high demand as relatively low. From an efficiency point of view, his behavior is distorted, because the producer does not take into account consumers' surplus. This leads the producer to opt for rationing too often. A regulation, such as a guarantee of availability, that corrects this behavior is therefore potentially beneficial.

A guarantee of availability forces the discounter to produce enough units for the high states of demand. Consequently, regulation results in more production. In settings with imperfect competition, where firms tend to produce inefficiently low quantities, such an increase in production enhances welfare. However, regulation overshoots its goal of adjusting production closer to the social optimum when the discounter must guarantee availability for states of demand that are rather unlikely. In this case, more sophisticated regulation is needed. A fine-tuning of regulation by an imposition of finite fines rather than an outright prohibition of rationing, seems therefore more appropriate. Such fines may take the form of a compensation to rationed consumers; an option suggested by the ministry of consumer protection. The compensation would make rationing a less favorable option for the firm and change the trade-off in favor of more production. The possibility of fine-tuning will however be severely limited, because the regulator will have less information about demand than the discounter. Also the enforcement of fine-tuned rules might be problematic.

The insight that the demand uncertainty leads to a trade-off between too much and too little production also allows a possibility that a regulator may actually prefer the firm to ration consumers. The results here were obtained under the premise that the regulator and firm agree about the cost of disposing unsold units. However, a difference in the firm's and regulator's perception of these costs may affect results. Specifically, if the regulator attaches, due to firm-external effects, a much higher cost to disposal than the firm, qualitative results are reversed.²¹ In this case, the regulator sees

²¹Interestingly, the German minister, Ms. Künast, who proposed the regulation belongs to the ecological conscious green party.

benefits in forcing the firm to produce less waste, which effectively implies that the regulator forces the firm to ration consumers.

Finally, the paper presents a model of bargain sales by stressing the importance of demand uncertainty. This is consistent with the empirical observation of rationing and excess supply. I used this model to investigate the regulation of availability. Yet, the persistence and increasing popularity of German bargain sales make it worthwhile to investigate this model further. It seems especially important to extend the model by introducing competition. Currently there exist up to seven discounters that are actively using the business model of bargain sales. Anecdotic evidence suggests that, while competition has increased, the problem of rationing has declined and the problem of excess supply has increased. It is an open question whether this is indeed a result of increased competition or merely reflects a temporary adjustment of the industry. Another open question concerns the demand uncertainty itself. Since the discounter is hurt by the uncertainty, it may look for active strategies to mitigate it. The discounter may, for instance, use repeated sales to test and acquire information about prospective demand. Such investigations may lead to a theory of optimal repeated sales that helps to understand the dynamics of German bargain sales.

8 Appendix

Proof of Proposition 1: From p_1^* it directly follows $q = D_l(p_1^*) = (3 - 4c - 4t)/8$. Q.E.D.

Proof of Proposition 2: Substitution of the demand functions $D_l(p)$ and $D_h(p)$ into (1) and maximization with respect to p_1 yields the result. Q.E.D.

Proof of Proposition 3: Due to the linearity of $\Pi(p, q)$ in q , the optimal q is either $3/4 - p - t$ or $1 - p - t$.

For $q = 3/4 - p - t$ the firm's profit is

$$\Pi_3(p, 3/4 - p - t) = (p - c)(3 - 4p - 4t)/4.$$

First order condition with respect to p are sufficient and yield $p_1^* = (3 + 4c - 4t)/8$ with quantity $q_1^* = (3 - 4c - 4t)/8$ and profit

$$\Pi_3(p_1^*, q_1^*) = (3 - 4c - 4t)^2/64. \quad (6)$$

For $q = 1 - p - t$ the firm's profit is

$$\Pi_3(p, 1 - p - t) = p(3 + \alpha - 4p - 4t)/4 - c(1 - p - t).$$

First order condition with respect to p are sufficient and yield $p_2^* = (3 + \alpha + 4c - 4t)/8$ with quantity $q_2^* = (5 - \alpha - 4c - 4t)/8$ and profit

$$\Pi_3(p_2^*, q_2^*) = (9 + \alpha^2 - 40c + 2\alpha(3 + 4c - 4t) - 24t + 16(c + t)^2)/64. \quad (7)$$

The difference in profits is

$$\Delta\Pi \equiv \Pi(p_2^*, q_2^*) - \Pi(p_1^*, q_1^*) = \alpha(6 + \alpha + 8c - 8t)/64 - c/4.$$

which is negative for $\alpha \in [0, \bar{\alpha})$ and positive for $\alpha > \bar{\alpha}$. Q.E.D.

Proof of Proposition 4: The difference in consumer surplus is

$$\Delta CS \equiv CS^2 - CS^1 = \frac{12 - 16c - \alpha(9 - 12c + 12t) + 64t - 64t(c + t)}{128(3 - 4c + 4t)/\alpha}.$$

It is positive if the numerator is positive. We show that the minimum of the numerator

$$12 - 16c - \alpha(9 - 12c + 12t) + 64t - 64t(c + t) \quad (8)$$

is positive. To see this, note that it holds $\partial\Delta CS/\partial c = 12\alpha - 16 - 64t < 0$ so that the numerator is falling in c . Since the parameter c lies in the interval $[0, \min\{3/4 - t, 1/2 + t\}]$, the minimum occurs either for $c = 3/4 - t$ or $c = 1/2 + t$. For $c = 3/4 - t$ expression (8) simplifies to $8(4 - 3\alpha)t$ which is positive. For $c = 1/2 + t$ the expression reduces to $4 - 3\alpha + 16t - 128t^2$, which itself is more than $1 + 16t - 128t^2$. As $c = 1/2 + t$ and $c < 3/4 + t$ implies that $t \leq 1/8$ the expression is positive. Hence, both candidates for a minimum of (8) are positive, so that ΔCS is positive itself for all parameter constellations. Q.E.D.

Proof of Proposition 5: Follows from the observation that (5) is positive if and only if $\alpha \in (\tilde{\alpha}, \bar{\alpha}]$. Q.E.D.

9 References

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